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EXAMINER

BROPHY, JAMIE LYNN

ART UNIT

PAPER NUMBER

2822

DATE MAILED: 08/20/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/986,267

Applicant(s)

NGO ET AL.

Examiner

J. L. Brophy

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 July 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-16 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,2 and 4-15 is/are rejected.
- 7) ☒ Claim(s) 3 and 16 is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 31 January 2003 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____.
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____.

DETAILED ACTION

This office action is in response to the RCE and Request for Reconsideration filed 7/16/03.

Continued Examination Under 37 CFR 1.114

A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 7/16/03 has been entered.

Response to Amendment

The declaration filed on 7/16/03 under 37 CFR 1.131 has been considered but is ineffective to overcome the Zhao et al (6,261,963) reference.

The evidence submitted is insufficient to establish diligence from a date prior to the date of reduction to practice of the Zhao et al (6,261,963) reference to either a constructive reduction to practice or an actual reduction to practice. Applicant alleges diligence in item #3 of the declaration, but does not provide any evidence of facts establishing diligence (MPEP 715.07(a)).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 1, 2, 4, 5, 7, 8, 11 and 13-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al (6,261,963) in view of Ritzdorf et al (Patent Application Pub. No. US 2002/0000271).

Rejection is maintained as shown in the office action mailed on 4/17/03.

Claims 6 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al in view of Ritzdorf et al as applied to claims 1, 2, 4, 5, 7, 8, 11 and 13-15 above, and further in view of Cabral et al (EP 0751566).

Rejection is maintained as shown in the office action mailed on 4/17/03.

Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al in view of Ritzdorf et al as applied to claims 1, 2, 4, 5, 7, 8, 11 and 13-15 above, and further in view of Islam et al (6,174,810).

Rejection is maintained as shown in the office action mailed on 4/17/03.

Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Zhao et al in view of Ritzdorf et al and Cabral et al as applied to claims 6 and 9 above, and further in view of Islam et al.

Rejection is maintained as shown in the office action mailed on 4/17/03.

Claims 1, 2, 4, 5 and 11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takagi et al (6,440,844) in view of Ritzdorf et al (Patent Application Pub. No. US 2002/0000271).

Takagi et al teach a method comprising forming an opening in a dielectric layer 3;
Depositing a barrier layer 10;
Depositing Cu 11 to fill the opening;
Conducting CMP such that an upper surface of the deposited Cu 11 is substantially co-planar with an upper surface of the dielectric layer 3 (Fig. 2C); and
Thermal annealing the deposited Cu 11 in NH₃ (col. 6, lines 19-31).
See Figs. 2A-2C and accompanying text.

However, Takagi et al do not specifically teach a laser thermal anneal.

Ritzdorf et al teach a method that comprises applying a laser thermal anneal to a copper layer 440. See Figs. 2E, 2F and 15 and accompanying text.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method taught by Takagi et al by laser thermal annealing the copper layer because laser annealing is more precise than furnace annealing (see Ritzdorf et al, p. 7, paragraphs [0070] – [0071]).

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Re claims 2 and 4, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to optimize and select an appropriate radiant fluence of the laser beam and a flow rate of the NH_3 . The selection of parameters such as energy, power, concentration, temperature, time, depth, thickness, etc., would have been obvious and involve routine optimization which has been held to be within the level of ordinary skill in the art. "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may be impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from results of prior art...such ranges are termed 'critical ranges' and the applicant has the burden of proving such criticality...More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation". *In Re Aller* 105 USPQ 233, 235 (CCPA 1955). See also MPEP 2144.05.

Claims 6 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over Takagi et al in view of Ritzdorf et al as applied to claims 1, 2, 4, 5 and 11 above, and further in view of Cabral et al (EP 0751566).

Takagi et al in view of Ritzdorf et al teach a method that comprises annealing a Cu or Cu alloy layer in NH_3 with a laser anneal. In addition, Takagi et al teach a barrier layer lining the opening before deposition of the Cu layer. Re claim 9, Takagi et al

teach the step of conducting CMP such that an upper surface of the deposited Cu 11 is substantially co-planar with an upper surface of the dielectric layer 3 (Fig. 2C).

However, Takagi et al in view of Ritzdorf et al do not teach that the barrier layer is a composite comprising a TaN layer on the dielectric layer, a layer of alpha-Ta on the TaN layer.

Cabral et al teach that the barrier layer 23 lining the opening in the dielectric layer 12 comprises a TaN layer on the dielectric layer, a layer of alpha-Ta on the TaN layer (col. 4, lines 47-49).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method disclosed by Takagi et al in view of Ritzdorf et al by forming the barrier layer of TaN/alpha-Ta in order to decrease the resistivity (see Cabral et al, col. 7, lines 11-23). See, for example, Fig. 1.

Claims 1, 2, 4, 5 and 7-15 are rejected under 35 U.S.C. 103(a) as being unpatentable over Islam et al (6,174,810) in view of Takagi et al and Ritzdorf et al.

Islam et al teach a method comprising forming an opening 50 in a dielectric layer 42, 46, wherein the opening 50 is a dual damascene opening containing a lower via hole section 54 in communication with an upper trench section 52, and wherein the dielectric layer 42, 46 may be TEOS (col. 5, lines 39-63);

Depositing a barrier layer 57 comprising tantalum or tantalum nitride or the like (col. 6, lines 30-38);

Depositing a seed layer 59 on the barrier layer 57;

Depositing Cu 60 by electroplating (col. 6, lines 46-50) to fill the opening 50 to form an upper line in communication with an underlying via;

Conducting CMP such that an upper surface of the deposited Cu 60 is substantially co-planar with an upper surface of the dielectric layer 46; and

Treating the upper surface of the Cu 60 in a plasma containing NH_3 and depositing a SiN capping layer 64 on the plasma treated surface by PECVD.

See Figs. 5-7 and accompanying text.

However, Islam et al do not specifically teach a laser thermal anneal. In addition, re claim 15, Islam et al do not specifically teach that the dielectric layer is a fluorine-containing silicon oxide derived from fluorine-doped TEOS.

Takagi et al teach a method that includes annealing a Cu layer in an NH_3 atmosphere (col. 6, lines 19-31). Ritzdorf et al teach a method that comprises applying a laser thermal anneal to a copper layer 440. See Figs. 2E, 2F and 15 and accompanying text.

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method taught by Islam et al by thermal annealing the copper layer because thermal annealing in NH_3 may be used in place of or in addition to plasma treatment in NH_3 (see Takagi et al, col. 6, lines 30-31). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to modify the method taught by Islam et al by laser thermal annealing the copper layer because laser annealing is more precise than furnace annealing (see Ritzdorf et al, p. 7, paragraphs [0070] – [0071]).

Re claims 2 and 4, it would have been obvious to a person of ordinary skill in the art at the time the invention was made to optimize and select an appropriate radiant fluence of the laser beam and a flow rate of the NH_3 . The selection of parameters such as energy, power, concentration, temperature, time, depth, thickness, etc., would have been obvious and involve routine optimization which has been held to be within the level of ordinary skill in the art. "Normally, it is to be expected that a change in temperature, or in concentration, or in both, would be an unpatentable modification. Under some circumstances, however, changes such as these may be impart patentability to a process if the particular ranges claimed produce a new and unexpected result which is different in kind and not merely degree from results of prior art...such ranges are termed 'critical ranges' and the applicant has the burden of proving such criticality...More particularly, where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation". *In Re Aller* 105 USPQ 233, 235 (CCPA 1955). See also MPEP 2144.05.

Allowable Subject Matter

Claims 3 and 16 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

The following is an examiner's statement of reasons for allowance: none of the references of record teach all of the process limitations as claimed. Specifically, none

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of the references teach a method that comprises laser thermal annealing to reflow the Cu or Cu alloy, in combination with the other claim limitations.

Response to Arguments

Applicant's arguments filed 7/16/03 have been fully considered but they are not persuasive. Since the declaration filed on 7/16/03 under 37 CFR 1.131 is ineffective, applicant's arguments are not found persuasive.

Applicant's arguments with respect to claims 1-16 have been considered but are moot in view of the new ground(s) of rejection.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to J. L. Brophy whose telephone number is (703) 308-6182. The examiner can normally be reached on M-F (8:00-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Amir Zarabian can be reached on (703) 308-4905. The fax phone numbers for the organization where this application or proceeding is assigned are (703) 872-9318 for regular communications and (703) 872-9319 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

J.L.B.

jlb

August 11, 2003



Michael Trinh
Primary Examiner
Act SPE